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DOCTOR OF MEDICINE

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STUDY OF RELATIONSHIP OF BODY MASS INDEX AND BLOOD PRESSURE IN SCHOOL GOING CHILDREN (ADOLESCENT AGE GROUP): A CROSS SECTIONAL STUDY

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LIST OF ABBREVIATIONS

1	BP	Blood Pressure
2	HTN	Hypertension
3	BMI	Body Mass Index
4	CV	Cardiovascular
5	LVH	Left Ventricular Hypertrophy
6	DASH	Dietary Approaches to Hypertension
7	CDC	Centers for Disease Control and Prevention
8	ABMP	Ambulatory Blood Pressure Monitoring
9	ARR	Aldosterone Renin Ratio
10	ACE INHIBITORS	Angiotensin Converting Enzyme Inhibitors
11	ARB'S	Angiotensin Receptor Blockers
12	CCB'S	Calcium Channel Blockers
13	IAP	Indian Academy of Pediatrics
14	WHO	World Health Organization

Introduction

INTRODUCTION

Hypertension is a major health problem in developing and developed countries. Hypertension is the most common cardiovascular disorder and public health challenge for societies in socioeconomic and epidemiological transition.

The insidious and steady history of hypertension in adults is a result of process that starts early in childhood and adolescent life, but possibly goes unobserved. Elevated blood pressure in children and adolescents may be an early expression of essential hypertension in adulthood.

Childhood essential hypertension is rising as is obesity [1–4] yet majority of times it remains underdiagnosed till early adulthood and often detected with the occurrence of some serious cardiovascular complications of long standing hypertension [5–8]. These two common non-infectious health conditions with serious long-term complications are entangled with today's life style of unhealthy dietary habits, increased affordability & more facilities associated with physical inactivity. The available data on prevalence of hypertension in children and its risk factors has shown wide variation ranging from 0.98% to 24%. [9–11], [12]

The plausible explanation for it could be the difference in lifestyle, local factors, etc. But it highlights the need of local data and follow up of the participants must be sustained for some years to detect the trend.

Early diagnosis and preventive intervention commencement early in life may reduce these risk of hypertension. Hence BP measurement plays an important role in diagnosis of hypertension in children.

Essential hypertension often presents with modest BP elevations. Being overweight or obese, a contributory family history (FH), higher dietary sodium intake, and premature birth are all associated with essential hypertension. As the earliest manifestation of adult cardiovascular disease, essential hypertension in children has yet to consider more. There is an urgent necessity for a simple and accurate screening method to identify pediatric hypertension. Obesity and positive family history are the major determinants of essential hypertension in adults and children. Overall and abdominal obesity, measured by body mass index (BMI) and waist circumference (WC), are common alternate measures of

adiposity in clinical and public health practice. Hypertension exhibits familial clustering, [11,12] and is associated with higher BP in children of hypertensive parents or grandparents. [12] However, there is a scarcity of data in the joint effect of FH and obesity on the risk of hypertension. [13]

Prevention control strategies generally target adults. In most of the children, measurement of blood pressure is a neglected part of physical examination. The American Heart Association endorses yearly measurements of blood pressure in all children from age of 3 years for tracking the BP from childhood into adulthood.[14]

Differences in the dietary pattern, lifestyle and physical activities are the principal contributors of overweight and obesity, accountable for variation in prevalence within the country. Nearly 50%–80% of obese children continues as obese in adulthood. The prevalence of hypertension (HTN) varies from 3.8% to 24.8% in children with overweight and obesity. Children with HTN and obesity may be accompanied by additional cardiometabolic risk factors such as dyslipidemia and disordered glucose metabolism, which may contribute their effects on BP or may represent comorbid conditions arising from the similar adverse lifestyle behaviors. Some researchers suggested, that the presence of multiple risk factors along with obesity and HTN increases the risk of cardiovascular (CV) diseases to great extent than by the individual risk factor alone.[2]

In children, Blood pressure studies provide important epidemiological information which may help in modifying or controlling the coronary arterial disease risk factors. various studies have established the standards for children of western world but currently there are no such standards available for Indian children, and the western standards cannot be applied to Indian children because of differences in factors such as socioeconomic, ethnic, dietetic and environmental factors between Indian and western countries.

Although this phenomenon has been hard to demonstrate conclusively, the strong heart study did show that American-Indian adolescents with several cardiometabolic risk factors had a higher prevalence of left ventricular hypertrophy, reduced left ventricular systolic and diastolic function and left atrial dilation compared with those without several cardiometabolic risk factors.[15] With this background, this study was proposed to find the effect of body mass index on blood pressure (BP) in school going children.[2]

This study is a timely contribution for understanding the relationship between body mass index and blood pressure among school going children , so that preventive measures, early detection and modifying the risk factors can protect these children from developing complications, thereby reducing morbidity and mortality.

Childhood hypertension is on rise globally yet it remains underdiagnosed. This study aims to document the prevalence of hypertension in adolescents and its risk factors.

Aims & Objectives

AIMS AND OBJECTIVES:

AIM

- To study the relationship of blood pressure with BMI in school going children aged 14 - 15 years.

OBJECTIVES

1. To study the relationship of blood pressure with abdominal obesity.
2. To study the relationship of blood pressure with positive family history of hypertension.
3. To study the prevalence of high blood pressure with number of family members having essential hypertension.

Review of Literature

REVIEW OF LITERATURE

Cardiovascular disorders are increasing in rank in developing countries and hypertension is the most common cause. Data on BP tracking from childhood to adulthood validate that higher BP in childhood associates with higher BP in adulthood and the onset of HTN in young adulthood. The strength of the tracking relationship is stronger in older children and adolescents. Trajectory data on BP (including repeat measurements from early childhood into mid adulthood) confirm the association of elevated BP in adolescence with HTN in early adulthood and that normal BP in childhood is associated with a lack of HTN in mid adulthood.

MEASUREMENT OF BLOOD PRESSURE IN CHILDREN

Arterial blood pressure can be assessed by two methods[16]

a. Indirect method

b. Direct method.

Indirect methods[16,17]

1. Auscultatory method by using sphygmomanometer
2. Oscillometric method
3. Flush method
4. Doppler method

Direct method

This technique includes direct measurement of arterial pressure by placing cannula in an artery [usually femoral, radial, brachial or dorsalis pedis]. the canula must be connected to a sterile, fluid filled system, which is connected to electronic monitor.

Importance of measurement of blood pressure and diagnosing Hypertension in Children and Adolescents

Numerous studies have revealed that elevated BP in childhood surges the risk for adult HTN and metabolic syndrome. Youth with higher BP levels in childhood are also more expected to have persistent HTN as adults. One recent study stated that adolescents with elevated BP advanced to HTN at a rate of 7% per year, and elevated BMI projected sustained BP elevations. In addition, young patients with HTN are expected to experience accelerated vascular aging. Both autopsy and imaging studies have demonstrated BP-associated CV damage in youth.[18]

ETIOLOGY

Primary hypertension (idiopathic, with unknown underlying cause) was earlier thought to be a diagnosis of exclusion in the paediatric population.[19] More recent evidence advocates increasing rates of primary hypertension corresponding with the obesity epidemic.[19] The most common type of hypertension in older children is Primary hypertension. Secondary hypertension (with an identifiable underlying cause) remains the most frequent etiology of high BP in young children and infants.[20] Hypertension from secondary causes was reported in 57% of 275 children with hypertension in a tertiary clinic. The median age of a child with secondary hypertension was 9 years.

Kidney disorders are the most common etiologies of secondary hypertension. 34% to 79% of secondary hypertension cases are Renal parenchymal conditions and structural abnormalities (such as glomerular, tubular, and interstitial abnormalities), while renovascular disorders (such as renal artery stenosis) are found in 12% to 13% of patients.(20)

Both renal parenchymal and renovascular disorders lead to activation of the renin-angiotensin-aldosterone system resulting in arterial vasoconstriction and volume expansion. (21)

Definition of pediatric hypertension

The clinical practice guideline comprises a number of important modifications to the BP classification that were recommended by the American Heart Association. [19] The guideline provides definitions of hypertension for two different age groups.

For children age 13 years and older, BP thresholds meeting the definition of hypertension replicate that for adults:

- **Normal BP**: <120/<80 mm Hg
- **Elevated BP (previously referred to as prehypertension):** systolic BP between 120 and 129 mmHg with a diastolic BP <80 mm Hg
- **Stage 1 hypertension:** BP between 130/80 mmHg and 139/89 mm Hg
- **Stage 2 hypertension**: BP ≥140/90 mm Hg. [19]

In 1 to 13 years aged children, BP levels defining hypertension are determined based on age, gender and height in normal-weight children: [19]

- **Normal BP**: both systolic BP and diastolic BP <90th percentile
- **Elevated BP (previously referred to as prehypertension)**: systolic BP and/or diastolic BP ≥90th percentile but <95th percentile or 120/80 mm Hg to < 95th percentile (whichever is lower)
- **Stage 1 hypertension:** systolic BP and/or diastolic BP ≥95th percentile to <95th percentile + 12 mm Hg or 130/80 mmHg to 139/89 mm Hg (whichever is lower)
- **Stage 2 hypertension:** systolic BP and/or diastolic BP ≥95th percentile + 12 mm Hg or ≥ 140/90 mmHg (whichever is lower). [19]

In distinction with adults, where cutoffs of BP replicate a degree of risk of poor cardiovascular outcomes, such as myocardial infarction or stroke, the definition of hypertension in children is based on the distribution of BP in healthy children with normal weight due to the rarity of these poor cardiovascular outcomes in the pediatric population and lack of data. Normative BP tables have been updated and published within the clinical practice guideline. [19]

MANAGEMENT OF PEDIATRIC HYPERTENSION

As suggested by the clinical practice guideline, the overall target of hypertension treatment is to reduce BP to less than the 90th percentile in children ages 13 years and younger or less than 130/80 mm Hg in adolescents. BP reduction in children decreases LVH and atherosclerosis that may render into a decline in cardiovascular complications later in life. [15]

Nonpharmacologic treatment. Nonpharmacologic therapies that support healthy nutrition, physical activity, and healthy weight should be suggested to all children with elevated BP and hypertension. The long-term beneficial effect of nonpharmacologic approaches was shown in a prospective study of 798 children that were followed for 20 years. [22] Hypertension resolution was seen in 44% of participants who were involved in healthy lifestyles.[22]

Dietary modifications, such as limited sugar intake; a reduction in salt intake; and an increased intake of fresh fruits, vegetables, whole grains, fish, poultry, nuts, lean red meats, and low-fat dairy products (Dietary Approaches to Stop Hypertension [DASH] diet), remain the keystone of treatment for children with hypertension.[20] Children with hypertension and overweight or obesity have to be referred to a paediatric dietitian, who may provide customized education and recommendations to progress overall nutrition and improve body weight. Referral to a paediatric obesity centre or intensive weight-loss program may be warranted. [23]

Regular physical activity is effective in lowering BP in children. The CDC recommends moderate-to-vigorous physical activity for at least 60 minutes daily for all children ages 6 to 17 years.[24] Children with hypertension should be encouraged, supported, and provided with opportunities to involve in physical activity. [20,24] Participation in intense physical training and competitive sports may present a challenge. Though there are no data on association among sudden death in athletes and hypertension, it is endorsed that children with stage 2 hypertension, even without evidence of LVH, be constrained from high-static sports such as weight lifting or wrestling until their BP is well controlled.

Tobacco smoking and other forms of nicotine inhalation in all children, including those with hypertension, should be discouraged. Though cigarette smoking can increase BP

due to the vasoconstrictive effect of nicotine, this increase in BP is only transient. [19] Smoking should be avoided not because it causes persistent hypertension but because it surges the risk of pulmonary and cardiovascular diseases. Several studies in adults have demonstrated a clear link between excessive alcohol consumption and development of hypertension. Despite uncertainties regarding this association in children, it is widely acknowledged that excess of alcohol pays to poor health. Alcohol consumption should be avoided in all children and adolescents, including those with hypertension.

The clinical practice guideline endorses that children with hypertension who are treated non pharmacologically should be followed up with every 3 to 6 months, so adherence to lifestyle modifications can be reinforced with education and support, and the need for pharmacologic therapies can be re-evaluated. [23] Ongoing patient and family education and support remain crucial.

Pharmacologic treatment. The decision to initiate antihypertensive medications should be based on the severity of hypertension and the presence of cardiovascular comorbidities. The treatment is indicated for children who have failed nonpharmacologic treatment, particularly those who have LVH or stage 2 hypertension. [23] These children are at higher risk and are likely to benefit from antihypertensive medications.

The number of antihypertensive drugs in children that have been evaluated for safety and efficacy has amplified after regulatory agencies both in the US and Europe legislatively incentivized paediatric trials.[23] As a result, efficacy and safety data for children are now available for drugs that have been newly introduced to the market. However, older, commonly prescribed antihypertensive medications were not re-evaluated for safety and efficacy in children and as such, information on dosing, adverse reactions, and efficacy is extrapolated from adult studies.[23]

Available data validate that main classes of antihypertensive medications are efficacious (compared with placebo), and well tolerated by children. [20,25] Because there is less data comparing antihypertensive drugs in children, the choice of agents should be based on the presence of comorbid conditions, practitioner's experience, and patient's preferences. [23,26] The clinical practice guideline provides recommendations on early medication doses.

For children without particular convincing indications, pharmacologic therapy can be initiated with one of the following classes: thiazide diuretics, angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs), or dihydropyridine calcium channel blockers (CCBs).[20] Beta-blockers are not recommended as initial therapy because they are less effective than other antihypertensive drugs. In addition, beta-blockers can cause bronchoconstriction in children with asthma. ACE inhibitors and ARBs have been found highly teratogenic and are contraindicated in pregnancy. Sexually active females should be treated with alternative medication classes.

In children with chronic kidney disease and diabetic nephropathy, ACE inhibitors and ARBs are recommended medication classes.[20] Based on convincing data from adult trials, ACE inhibitors and ARBs decrease albuminuria and slow progression of renal insufficiency. However, ACE inhibitors and ARBs may decrease a patient's glomerular filtration rate, so careful monitoring for a Closely monitor potential rise in creatinine and potassium is required. Children with chronic kidney disease should be managed by a paediatric nephrologist or a cardiologist.

The updated guidelines recommend that patients treated with pharmacologic agents should be reassessed every 4 to 6 weeks for dose adjustments until goal BP is achieved, then every 3 to 4 months after. Consider a second or third medication from a different medication class if target BP is not achieved on monotherapy. Secondary hypertension and poorly controlled primary hypertension requiring multiple medications warrants referral to a specialist.[20]

Monitor children on antihypertensive medications closely for adverse reactions of prescribed medications, particularly electrolyte imbalances. Repeat echocardiography to assess progression or regression of LVH should be obtained for children with stage 2 hypertension and those with abnormal left ventricular function. Frequent echocardiography in the absence of LVH is discouraged.[20]

IMPORTANT CHANGES/NEW STATEMENTS IN THE CLINICAL PRACTICE GUIDELINE ON ELEVATED BLOOD PRESSURE BY AMERICAN ACADEMY OF PEDIATRICS, 2017 [27]

• Latest blood pressure charts for boys and girls.

• Blood pressure classification has been revised.

• Stepwise guidelines specified for managing children with increased blood pressure (BP).

• Amplified stress on importance of Ambulatory blood pressure monitoring (ABPM) in management and diagnosis of childhood hypertension.

– ABPM has been sturdily recommended for confirming a diagnosis of hypertension (HTN) in children and adolescents if they have office BP measurements in the higher BP category for 1 year or more or with Hypertension stage 1 over 3 clinic visits.

–To suspect White-coat hypertension or Masked hypertension ABPM should be done.

– In special group of populations such as chronic kidney disease and post transplantation its use is particularly recommended.

• Children of age ≥ 6 years were recommended to not regularly require extensive investigation for secondary causes of HTN if they have a positive family history of HTN, are overweight or obese, and/or do not have history or physical examination findings suggestive of a secondary cause of HTN. Monogenic Hypertension should be suspected in children with positive family history of early-onset Hypertension, hypokalemia, suppressed plasma renin, or an elevated Aldosterone Renin Ratio.

• Renovascular HTN have to be suspected in children with HTN stage 2, significant diastolic HTN, different kidney sizes on ultrasound, hypokalemia on screening investigations, or an upper abdominal and/or epigastric bruit on physical examination.

• Electrocardiogram is not recommended for assessing left ventricular hypertrophy.

• Echocardiography strongly recommended to assess for target organ damage at the time of reflection of pharmacologic treatment of HTN.

• Doppler renal ultrasonography may be useful in evaluation of renal artery stenosis in normal weight children and adolescents of age ≥8 years who will cooperate with the procedure.

• Indication for the initiation of treatment – In hypertensive adolescents and children who have failed lifestyle alterations. – Those with target organ damage such as LVH,

Symptomatic Hypertension, or stage 2 hypertension without a evidently modifiable risk factor (eg: obesity).

• BP Target: Reduction in diastolic BP and systolic BP to <90th percentile

• Beta blocker should not be used as initial anti- hypertensive. Usual choice of anti-hypertensive should include ACE inhibitors, ARB, long-acting calcium channel blocker, or thiazide diuretic.

Kishor kumar D et al.,(2016) studied the prevalence of hypertension among school children in rural area of Tamil Nadu. In their study they stated that the prevalence of hypertension and pre-hypertension was 10% and 14.2%, respectively. Prevalence was significantly higher among private school students. Increasing prevalence of hypertension might be due to childhood obesity as well as growing awareness of the diseases. The authors recommend that children must be screened for hypertension for early diagnosis and prevention of complications. [(28)]

Sabapathy S et al.,(2017) in a cross sectional study in Bangalore Rural District examined a total of 1024 school children between 6 to 16 years of age in both government and private school and studied the prevalence of childhood hypertension and prehypertension. The prevalence of hypertension in their study was 2.7% and prehypertension is 3.2%. In government school children 0.8% were pre-hypertensive and1.7% were hypertensive. In private school children 5.1% were pre-hypertensive and 3.5% were hypertensive. They concluded that childhood hypertension is prevalent in both government and private schools, with higher prevalence in private schools. Blood pressure measurement should be made mandatory in all school children. [(29)]

jena et al (2018) in their study **Relationship between body mass index and blood pressure in school students** included 580 students of 6–12 years age group of both boys and girls. Obesity and Overweight were higher in boys than girls. There was significantly high BP in obese and overweight participants than healthy weight individuals. There was positive correlation between BP both systolic and diastolic BP and BMI. HTN Prevalence was more in boys than girls. Odds ratio suggested that obesity and overweight were associated with HTN.[(2)]

Rangaswamy K et al in their study on Blood pressure and its correlation with age and BMI among the school children between 10 and 16 years of age(2019) at salem, Tamil Nadu stated that the prevalence of hypertension was more among the students in overweight and obese category than that of normal or underweight category both among males and females and this association between BMI and hypertension was found to be statistically significant.[30]

Mehta et al (2020) done cross-sectional observational study was conducted among 1000 school-going urban children between 6 and 14 years of age from January 2018 to June 2019 explained that the prevalence of Hypertension was found to be more significant in overweight and obese children as compared to normal weight children.[7]

Barati et al(2021) in their study Overweight and obesity: worldwide risk factors for paediatric hypertension specified that respectively 3.8 and 4.5% of the boys and girls were underweight, 17.4 % of the boys and 16.5% of the girls were overweight, and 20.8 of the boys and 19.3% of the girls were obese. In addition, 3.4 of the subjects had presystolic, 0.7 of the subjects had systolic and 0.4% of the subjects had prediastolic HTN. There is a significant linear relationship between systolic and diastolic blood pressures and BMI.[3]

Material & Methods

MATERIAL AND METHODS

- **SOURCE OF DATA :**

  The schools were selected by simple random sampling among the clusters of schools in Ghaziabad. The school children in the age group of 14-15 years were selected for the study among these schools chosen for study.

- **ETHICAL CLEARANCE :**

  Permission was taken from the ethical committee of the institute to conduct the study.

- **STUDY DESIGN** : cross sectional study

- **STUDY PERIOD :**18 months, from April 2021- December 2022

- **PLACE OF STUDY**

  The present study was undertaken in a public school in urban western Uttar Pradesh situated in vicinity of study center

- **SAMPLE SIZE** :

  The sample size was calculated using formula

  $n=Z^2P(1-P)/d^2$,

  where prevalence used was 6 %[6] and d was 5% precision.

  The sample size required using this formula was 90.

  But it was decided to increase the number of participants to improve the accuracy and significance of observations 816 children studying in class 9^{th}, age group 14-15 years were included after consent and assent.

INCLUSION CRITERIA –

1. Apparently healthy school children in the age group of 14-15 years.

EXCLUSION CRITERIA –

1. Children other than age group of 14 -15 years.
2. Children with cardiac disorders, renal disorders.
3. Children with any chronic illness or any history of drug intake known to influence blood pressure.
4. Failure to obtain consent from parents or care givers.

DATA MANAGEMENT AND STATISTICAL ANALYSIS:-

The study was approved by Institute ethics committee. Necessary permission was obtained from school authorities and parental consent was must for participation in the study. The data collected was age, family history of hypertension, abdominal girth, weight & height which were used to calculate Body mass index (BMI) using formula BMI=weight(K)/Height(mt^2). Age and gender specific IAP charts were used to classify the children as having normal BMI, overweight (85^{th} centile to 95^{th} centile) or obese (above 95^{th} centile).

Statistical analysis was done using MS excel and Stata software. Basic descriptive statistics (mean & standard deviation) were calculated for BMI, age, waist circumference and blood pressure (both systolic and diastolic). Odds ratio were calculated with 95% confidence interval and chai square test was applied for association between categorical variables

METHODOLOGY –

The present study was a cross sectional study undertaken in a public school in urban western Uttar Pradesh situated in vicinity of study center between April 2021 to January 2022.

The sample size was calculated using formula $n=Z^2P(1-P)/d^2$, where prevalence used was 6 %[6] and d was 5% precision.

The sample size required using this formula was 90. But it was decided to increase the number of participants to improve the accuracy and significance of observations 816 children studying in class 9th, age group 14-15 years were included after consent and assent.

Children with any renal disease associated with secondary hypertension or taking medication known to affect blood pressure were excluded.

Blood pressure was recorded in sitting position in left arm after ensuring a rest of 15 minutes. Before recording the blood pressure, the procedure was fully explained to children and reassured that procedure is neither painful nor harmful.

After giving 5-10 minutes rest, blood pressure was recorded in sitting position with the back supported; feet on floor and right arm supported with cubital fossa at heart level.

The appropriately sized cuff was selected with the bladder width about 40% of arm circumference at a point midway between olecranon and acromion and bladder length covering at least 80% to 100% of circumference of arm.

For each child it was recorded thrice at an interval of 5 minutes in between each reading and mean of these three readings was the value used for statistical calculations. Blood pressure was recorded by Omron digital BP monitor with appropriate size cuff. The child was considered normotensive if blood pressure was less than 90th percentile.

The percentile charts based on gender, age and height provided by NHBPEP were used for classification of blood pressure.

If blood pressure was ≥ 90th percentile, blood pressure was rechecked at same visit after 1 hour.

If blood pressure was persistently abnormal even in second screening blood pressure was rechecked twice at one week interval.

If at the end of fourth screening, BP was persistently elevated to between ≥ 90th percentile to 95th percentile, child was considered having prehypertenson.

If BP at end of fourth screening was ≥ 95th percentile, child was considered as having hypertension.

The blood pressure between 90^{th} to 95^{th} centile was considered as prehypertension & above 95^{th} centile as hypertension.

Observation & Results

OBSERVATION AND RESULTS

The sample comprised of 816 children with a mean age of 14.5 months =/- 0.5 years with almost equal number of males to female. Overall prevalence of prehypertension & hypertension was 9.5% & 5.3% respectively.

The prevalence of overweight & obesity was 19.1% &9.6% respectively. Hypertension was commoner in overweight & obese children as compared to normal BMI children. This difference in the prevalence of hypertension in different BMI category was statistically significant (p value <0.001).

Prevalence of hypertension was also higher in children with abdominal obesity & in those with positive family history of hypertension. The prevalence of high blood pressure increased if the number of family members having essential hypertension was more.

Table I presents the characteristics of the study population.

Table II presents the distribution of Prehypertension & hypertension in study participants according to BMI status.

Figure 1 shows the prevalence of prehypertension and hypertension in study participants stratified by BMI categories of obese, overweight, and normal. Both hypertension and prehypertension were commoner in children with BMI above normal.

Table III shows impact of positive family history of hypertension in individuals with normal BMI category. Children with positive family history of hypertension had higher odds of having hypertension as compared to negative family history counterparts with normal BMI.

Figure 2 shows the Prevalence of Blood Pressure with Gender in The Total Population.
Figure 3 shows the Distribution of blood pressure status according to Abdominal obesity.

Figure 4 shows the Distribution of blood pressure status according to Family History of Hypertension.

Figure 5 shows the Distribution of blood pressure status according to Number of Family Members with positive history of Hypertension.

Table II: Distribution of Prehypertension & hypertension in study participants according to BMI category.

BMI category	Total	Combined (Prehypertension + Hypertension)	Prehypertension	Hypertension
	N=816	n=121(14.8)	n=78(9.5)	N=43(5.3)
Normal	582	66(11.3)	44(7.5)	22(3.7)
overweight	156	29(18.5)	19(12.1)	10(6.4)
obese	78	26(33.3)	15(20.5)	11(12.8)

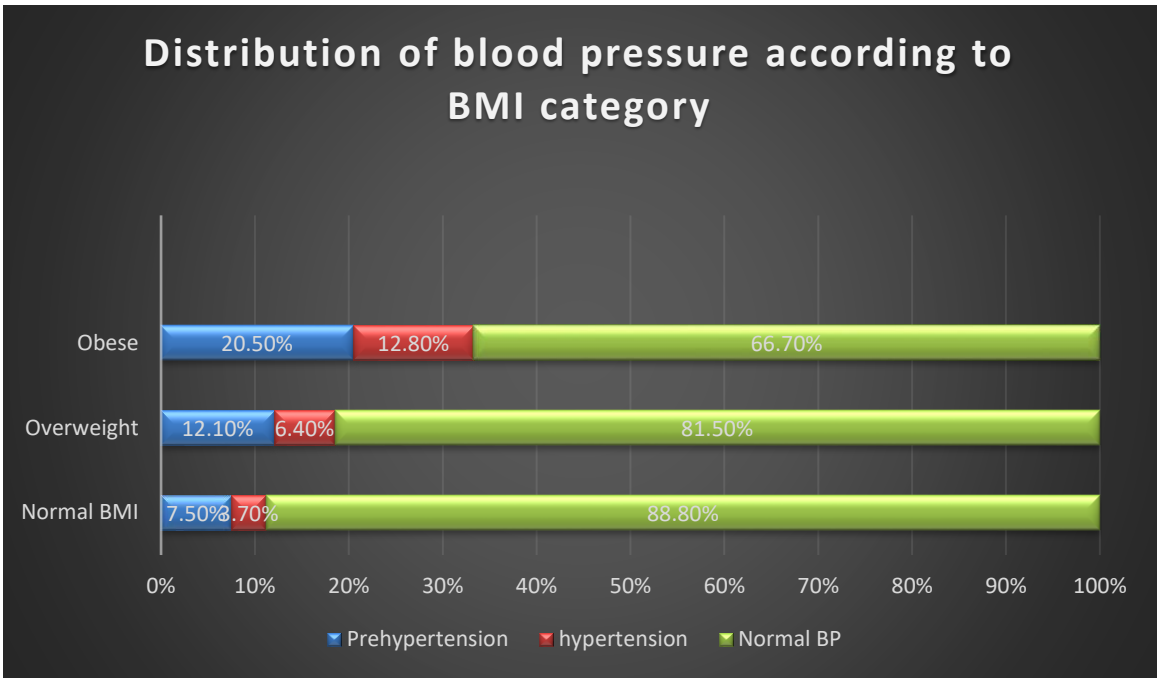

Figure 1: The prevalence of normal blood pressure, prehypertension, and hypertension according to the BMI category in study participants.

Table III: Analysis of adolescents with normal BMI status (Total number=582), with hypertension (number =66) and positive family history of hypertension.

	High BP n	**Normal BP** N	**Odd's ratio**	**Confidence interval**
Positive family history of Hypertension	34	142	2.7	(4.54,1.60)
Negative family history of Hypertension	32	374	-	-
Total N=582	66	516		

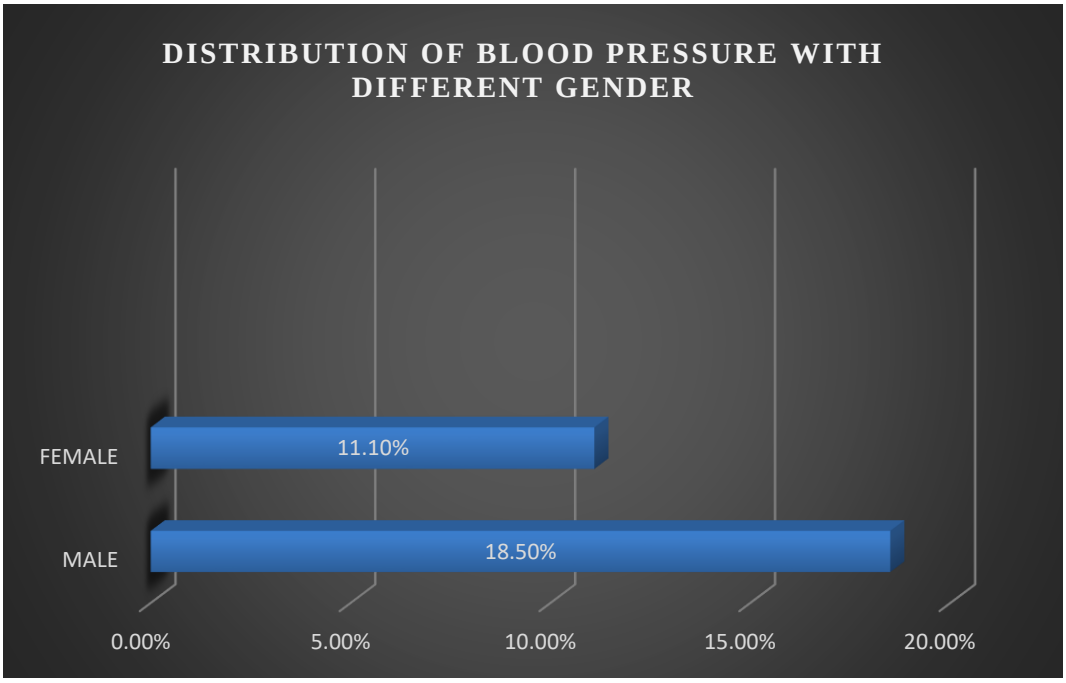

FIGURE 2: Prevalence of Blood Pressure with Gender In The Total Population.

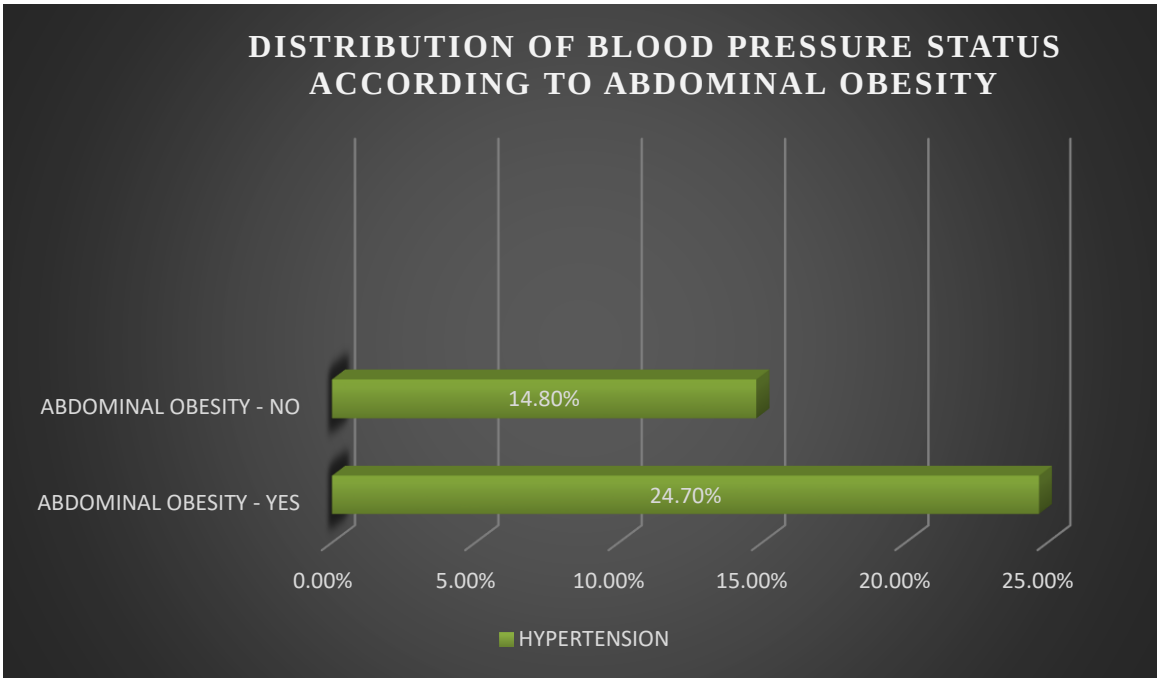

FIGURE 3: Distribution of blood pressure status according to Abdominal obesity.

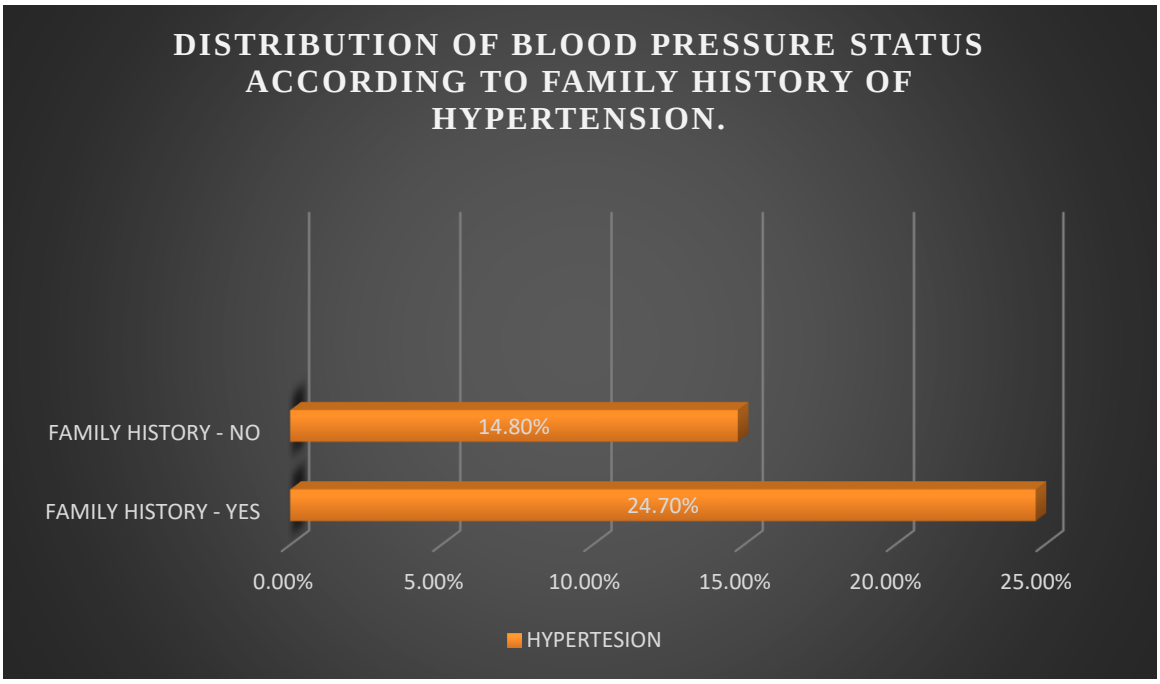

FIGURE 4: Distribution of blood pressure status according to Family History of Hypertension.

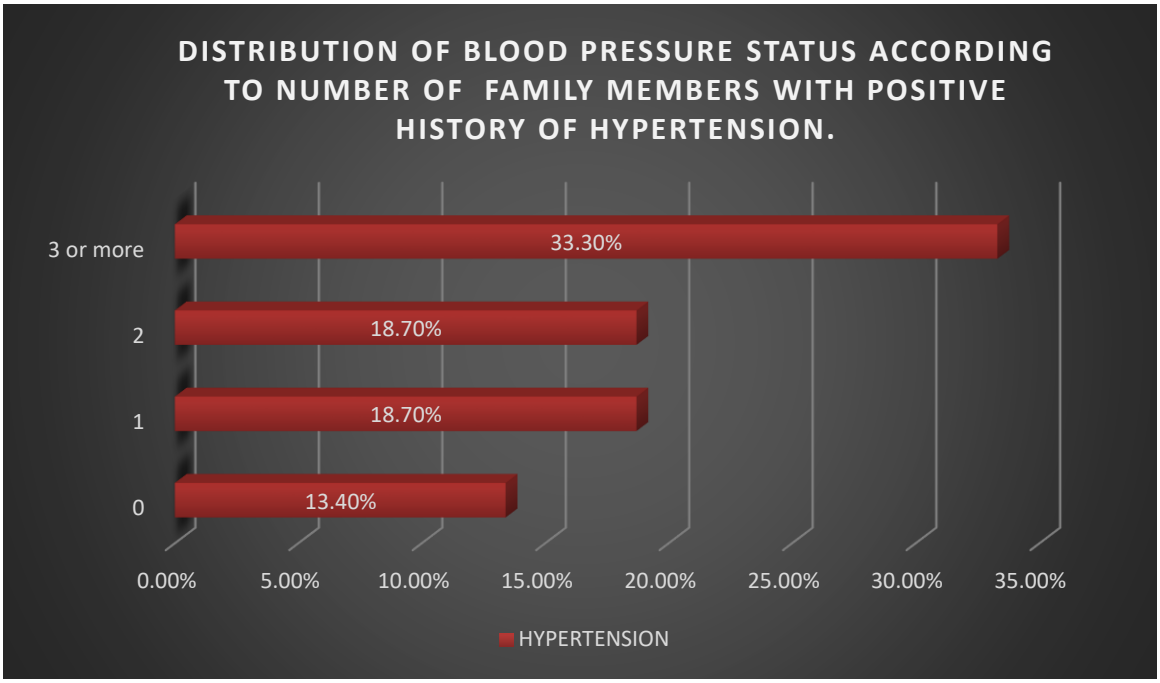

FIGURE 5: Distribution of blood pressure status according to Number of Family Members with positive history of Hypertension.

Discussion

Discussion

Present study was aimed to get an insight on prevailing prevalence of hypertension and obesity in adolescents in the served population, and to study the association of hypertension with some commonly implicated risk factors like overweight/obesity and positive family history of hypertension.

The prevalence of **prehypertension & hypertension in present study** was 9.5% &5.3%respectively, much higher than the values quoted by studies about a decade old.

The observations of present study are in concordance with the results of a recent study from Mumbai [(6)],they reported prevalence of prehypertension and hypertension in 9-15 years old children as 7.5% and 5.4% .

Much higher prevalence of hypertension at 24.41% in urban school going adolescents (13 to 17 years) was reported from Chennai [(9)].

Prevalence of 16.2% was reported from Rajasthan [(5)] ,15.3% from Manipur in 5-15 years old children [(31)].

Low prevalence of hypertension at 1.3% was reported from Guntur in a recent study[(32)]& 0.98% from Pondicherry[(10)]

The data available related to the subject is patchy and it is difficult to compare the results as lifestyle habits vary greatly across the country. So the follow-up studies will be required to compare, to know the trends of prevalence & to formulize the corrective steps.

Overweight/obesity

In present study the prevalence of overweight & obesity was high at 19.1% & 9.6% respectively.

Even higher prevalence of overweight & obesity as 20.18% &16.01% has been reported recently (2018) from Mumbai in urban school going adolescents [(6)].

Slightly lower prevalence has been reported from Rajasthan[7] .Their study included 6 to 14 years old children & the reported prevalence of overweight & obese was 11.2% & 5.2%.

The rising trend of overweight/obesity becomes apparent by looking at a decade old studies in which the prevalence was lower and ranged from 16% [33] (2012),18.1% to 21.2%(2014) [12]

High blood pressure and overweight/obesity

18.5% overweight & 33% of obese children in present study had prehypertension/hypertension in comparison to 11.3% of children with normal BMI. This observation is similar to the findings of [6], they enrolled 1486(9-15 years old children),and reported that 14% of overweight and 30.2% of obese children had prehypertension or hypertension.

The results of present study are also in concordance with a study [34] from Chennai, they reported that 52.1% of overweight & 56.2% of obese adolescents (13-17 years)in their study had Blood pressure in prehypertension or hypertension range.

In a megaproject named ORANGE from Chennai (2014)the reported prevalence of prehypertension & hypertension in adolescents was 20.4% & 5.2% respectively [12]. Another recent study from China on adolescents reported the prevalence of hypertension as 33% in obesity/ overweight children [13].

Strong association between BMI and blood pressure has been studied extensively. A study from Iran among 3-6 years old children reported a significant linear relationship between BMI and systolic and diastolic blood pressures[35].

A study from Tamil Nādu in 10-16 years old children reported strong positive association between BMI and hypertension [36].

The confirmed increasing trend of high prevalence of prehypertension/hypertension in adolescents especially those with high BMI has pushed the researchers into tracking these children till adulthood and reported that more than 70% subjects with high BP 90

to 95th centile/prehypertensive range) continued to have blood pressure in same centiles even in adulthood.

There are studies which report that other than body mass index other indicators of obesity like waist hip ratio, abdominal circumference were also independent risk factors for both hypertension and pre-hypertension[37].

Association between BP & positive family history of hypertension

In present study the Children with positive family history of hypertensive parents or grandparents were at higher risk of having hypertension than those without.

odds of having high BP were 2.7 times more in those with positive family history in comparison to their counter parts with negative family history of hypertension. This finding is similar to the observations of many studies from all over India and world.[34,38][1,13]

Summary & Conclusion

SUMMARY & CONCLUSION

The prevalence of prehypertension /hypertension & overweight/ obesity in adolescents in present study was high as compared to the studies done about a decade ago.

The strong association of BMI and blood pressure was evident in present study. as there was statistically significant higher prevalence of pre hypertension/hypertension in overweight/obese children as compared to normal BMI counterparts.

Another important risk factor for hypertension in children was positive family history of high blood pressure.

Periodic surveys should be done in schools to identify the children of “at risk” group and adolescents who can develop HTN in future, so that preventive care can be provided and further emphasize for future research in adolescents by using all three steps of WHO stepwise approach and to measure overweight/obesity by using BMI along with other anthropometric methods such as waist circumference would improve the validity of the study.

These were the reasons to plan this study to know the magnitude of hypertension and obesity in adolescents in the served population.

In Conclusion:

1. The prevalence of hypertension among the adolescent age group was alarmingly high.
2. Obesity, gender, family history of HTN and increased waist/hip ratio were found to be the major determinants of Adolescent HTN.
3. There was no association found between food habits and Physical activity.

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Annexure

PROFORMA

SANTOSH MEDICAL COLLEGE & HOSPITAL

PATIENT INFORMATION SHEET

Case No. :

Name :

Age :

Sex :

Address:

Phone No:

History:

History of any chronic illness:

History of Hypertension in family:

Biophysical profile :

Height :

Weight :

BMI :

Normal :

Over weight :

Obese :

BP :

Normal :

PreHypertension :

Hypertension :

SANTOSH MEDICAL COLLEGE & HOSPITAL

CONSENT FORM

I……S/O,D/O……R/O ……... have been explained by Dr. RAKESH SHETTY about the implications and Procedure of the study. I volunteer to take part in the study titled "**STUDY OF RELATIONSHIP OF BODY MASS INDEX AND BLOOD PRESSURE IN SCHOOL GOING CHILDREN (ADOLESCENT AGE GROUP): A SCHOOL BASED CROSS SECTIONAL STUDY**" I have been explained the purpose of the study to my satisfaction.

I hereby give my consent to be enrolled in the study.

Signature of volunteer/guardian

Signature of Investigator

Signature of Witness Phone No.

annexure 1

SANTOSH MEDICAL COLLEGE & HOSPITAL

Informed Consent Form

I ……..son/daughter/wife of…….resident of ……..give my full and voluntary consent to be included as a subject in the study **" STUDY OF RELATIONSHIP OF BODY MASS INDEX AND BLOOD PRESSURE IN SCHOOL GOING CHILDREN (ADOLESCENT AGE GROUP): A SCHOOL BASED CROSS SECTIONAL STUDY "** that the study will be conducted in santosh hospital. I have been explained ,in my own language ,and to my full satisfaction ,the aim and nature of the study and the risks .I have also been explained that my confidentiality will be maintained and all the investigations/interventions will be carried out only after my consent is obtained. I am aware of my right to opt out of the study at any point without giving any reason, and without penalty or loss of routine care benefits. My project does not involve any risk .

Name of the Participant

Address of Participant Phone No.-

Date & Time

Dr.RAKESH SHETTY

P.G.Student –MD Paediatrics

Santosh Hospital,Ghaziabad Thumb Impression/Signature

संतोष मेडिकल कॉलेज और अस्पताल

सहमतिपत्र

मैं_____ पुत्र / पुत्री/धर्मपत्नी_____

निवासी_____ को डॉक्टर **Dr. RAKESH SHETTY** द्वारा इस शोधकार्य के सम्बन्ध में होने वाली हानि के बारे में समझा दिया है और मैं इच्छापूर्वक इस शोधकार्य जिसका शीर्षक **" STUDY OF RELATIONSHIP OF BODY MASS INDEX AND BLOOD PRESSURE IN SCHOOL GOING CHILDREN (ADOLESCENT AGE GROUP): A SCHOOL BASED CROSS SECTIONAL STUDY "** है और इस शोधकार्य के बारे में समझा दिया गया है**।** अतःमैंउपरोक्त विषय पर शोधकार्य में हिस्सा लेने के लिए सहमत हूँ**।** मुझे समझा दिया गया है की किसी प्रतिकूल प्रतिक्रिया के होने पर इलाजऔर मुआवजे की ज़िम्मेदारी जांच अधिकारी की है**।** मेरी सभी जानकारी गुप्त रखी जाएगी और मुझे किसी भी समय यह जांच छोड़ने का पूरा अधिकार है**।** मुझे समझा दिया गया है की इस जांच के दौरान मुझे कोई खतरा नहीं है**।**

हस्ताक्षर

जांचअधिकारीकेहस्ताक्षर

गवाह

दूरभाषनंबर

दिनांक

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Entire Document

INTRODUCTION Hypertension is a major health problem in developing and developed countries. Hypertension is the most common cardiovascular disorder and public health challenge for societies in socioeconomic and epidemiological transition. The insidious and steady history of hypertension in adults is a result of process that starts early in childhood and adolescent life, but possibly goes unobserved. Elevated blood pressure in children and adolescents may be an early expression of essential hypertension in adulthood. Childhood essential hypertension is rising as is obesity (1–4) yet majority of times it remains underdiagnosed till early adulthood and often detected with the occurrence of some serious cardiovascular complications of long standing hypertension (5–8). These two common non-infectious health conditions with serious long-term complications are entangled with today's life style of unhealthy dietary habits, increased affordability & more facilities associated with physical inactivity. The available data on prevalence of hypertension in children and its risk factors has shown wide variation ranging from 0.98% to 24% (9–11), (12) The plausible explanation for it could be the difference in lifestyle, local factors, etc. But it highlights the need of local data and follow up of the participants must be sustained for some years to detect the trend. Early diagnosis and preventive intervention commencement early in life may reduce these risk of hypertension. Hence BP measurement plays an important role in diagnosis of hypertension in children. Essential hypertension often presents with modest BP elevations. Being overweight or obese, a contributory family history (FH), higher dietary sodium intake, and premature birth are all associated with essential hypertension.9 As the earliest manifestation of adult cardiovascular disease, essential hypertension in children has yet to consider more. There is an urgent necessity for a simple and accurate screening method to identify pediatric hypertension. Obesity and positive family history are the major determinants of essential hypertension in adults and children.10 Overall and abdominal obesity, measured by body mass index (BMI) and waist circumference (WC), are common alternate measures of adiposity in clinical and public health practice. Hypertension exhibits familial clustering, (11,12) and is associated with higher BP in children of hypertensive parents or grandparents. (12) However, there is a

Master Chart

S.NO	AGE	SEX	BMI	BP CLASSSIFICATION	FAMILY HISTORY OF HYPERTENSION
1	14	2	2	1	1
2	14	1	1	1	1
3	14	2	1	1	2
4	14	1	2	3	2
5	14.5	2	1	1	1
6	14	1	1	1	2
7	14.5	2	1	1	2
8	14.5	1	3	1	2
9	14	2	1	1	2
10	14.5	1	1	1	2
11	14	2	2	1	2
12	14	1	1	1	1
13	14	2	1	1	2
14	14	1	2	1	2
15	14.5	2	1	1	1
16	14	1	1	1	2
17	14.5	2	1	2	2

18	14.5	1	3	1	1
19	14	2	1	1	2
20	14.5	1	1	1	2
21	14	2	2	1	2
22	14	1	1	1	1
23	14	2	1	1	2
24	14	1	2	1	2
25	14.5	2	1	1	2
26	14	1	1	2	2
27	14.5	2	1	1	1
28	14.5	1	3	1	2
29	14	2	1	1	2
30	14.5	1	1	1	2
31	14	2	2	1	2
32	14	1	1	1	1
33	14	2	1	1	2
34	14	1	2	1	2
35	14.5	2	1	1	2
36	14	1	1	2	1
37	14.5	2	1	3	2
38	14.5	1	3	1	2
39	14	2	1	1	2
40	14.5	1	1	1	2

41	14	2	2	2	2
42	14	1	1	1	2
43	14	2	1	1	1
44	14	1	2	1	2
45	14.5	2	1	1	2
46	14	1	1	1	2
47	14.5	2	1	1	1
48	14.5	1	3	2	2
49	14	2	1	1	2
50	14.5	1	1	1	2
51	14	2	2	1	2
52	14	1	1	1	2
53	14	2	1	1	1
54	14	1	2	1	2
55	14.5	2	1	2	2
56	14	1	1	1	2
57	14.5	2	1	1	1
58	14.5	1	3	1	2
59	14	2	1	1	2
60	14.5	1	1	1	2
61	14	2	2	1	1
62	14	1	1	1	2
63	14	2	1	1	2

64	14	1	2	1	1
65	14.5	2	1	1	2
66	14	1	1	1	1
67	14.5	2	1	1	2
68	14.5	1	3	1	2
69	14	2	1	1	2
70	14.5	1	1	2	2
71	14	2	2	1	1
72	14	1	1	3	2
73	14	2	1	1	2
74	14	1	2	1	1
75	14.5	2	1	1	2
76	14	1	1	1	2
77	14.5	2	1	1	1
78	14.5	1	3	3	2
79	14	2	1	1	2
80	14.5	1	1	1	2
81	14	2	2	1	1
82	14	1	1	1	2
83	14	2	1	1	2
84	14	1	2	2	2
85	14.5	2	1	1	1
86	14	1	1	1	2

87	14.5	2	1	1	2
88	14.5	1	3	1	1
89	14	2	1	1	2
90	14.5	1	1	1	1
91	14	2	2	1	2
92	14	1	1	1	2
93	14	2	1	1	2
94	14	1	2	1	2
95	14.5	2	1	1	1
96	14	1	1	1	2
97	14.5	2	1	3	2
98	14.5	1	3	1	2
99	14	2	1	1	1
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688	14.5	1	3	1	1
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690	14.5	1	1	2	1
691	14	2	2	1	2
692	14	1	1	1	2
693	14	2	1	1	2
694	14	1	2	1	2
695	14.5	2	1	1	1
696	14	1	1	1	2
697	14.5	2	1	1	2
698	14.5	1	3	2	2
699	14	2	1	1	1
700	14.5	1	3	1	1
701	14	2	2	2	1
702	14	1	1	3	1
703	14	2	1	1	2
704	14	1	2	1	2
705	14.5	2	1	1	1
706	14	1	1	1	2
707	14.5	2	1	1	2

708	14.5	1	3	1	2
709	14	2	1	1	2
710	14.5	1	1	1	2
711	14	2	2	1	2
712	14	1	1	1	1
713	14	2	1	1	2
714	14	1	2	1	2
715	14.5	2	1	1	1
716	14	1	1	1	2
717	14.5	2	1	1	2
718	14.5	1	3	1	1
719	14	2	1	2	2
720	14.5	1	1	1	2
721	14	2	2	1	2
722	14	1	1	1	1
723	14	2	1	1	2
724	14	1	2	1	2
725	14.5	2	1	1	2
726	14	1	1	2	2
727	14.5	2	1	1	1
728	14.5	1	3	1	2
729	14	2	1	1	2
730	14.5	1	1	1	2

731	14	2	2	1	2
732	14	1	1	1	1
733	14	2	1	1	2
734	14	1	2	1	2
735	14.5	2	1	1	2
736	14	1	1	1	1
737	14.5	2	1	1	2
738	14.5	1	3	1	2
739	14	2	1	1	2
740	14.5	1	1	1	2
741	14	2	2	3	2
742	14	1	1	1	2
743	14	2	1	1	1
744	14	1	2	1	2
745	14.5	2	1	1	2
746	14	1	1	1	2
747	14.5	2	1	1	1
748	14.5	1	3	3	2
749	14	2	1	1	2
750	14.5	1	1	1	2
751	14	2	2	1	2
752	14	1	1	2	2
753	14	2	1	1	1

754	14	1	2	1	2
755	14.5	2	1	1	2
756	14	1	1	1	2
757	14.5	2	1	1	1
758	14.5	1	3	2	2
759	14	2	1	1	2
760	14.5	1	1	1	2
761	14	2	2	1	1
762	14	1	1	1	2
763	14	2	1	1	2
764	14	1	2	1	1
765	14.5	2	1	1	2
766	14	1	1	1	1
767	14.5	2	1	1	2
768	14.5	1	2	1	2
769	14	2	1	1	2
770	14.5	1	1	1	2
771	14	2	2	1	1
772	14	1	1	1	2
773	14	2	1	2	2
774	14	1	2	1	1
775	14.5	2	1	1	2
776	14	1	1	1	2

777	14.5	2	1	1	1
778	14.5	1	3	1	2
779	14	2	1	1	2
780	14.5	1	1	1	2
781	14	2	2	2	1
782	14	1	1	1	2
783	14	2	1	1	2
784	14	1	2	1	2
785	14.5	2	1	1	1
786	14	1	1	1	2
787	14.5	2	1	1	2
788	14.5	1	3	1	1
789	14	2	1	1	2
790	14.5	1	1	2	1
791	14	2	2	1	2
792	14	1	1	1	2
793	14	2	1	1	2
794	14	1	2	3	2
795	14.5	2	1	1	1
796	14	1	1	1	2
797	14.5	2	1	1	2
798	14.5	1	2	1	2
799	14	2	1	1	1

800	14.5	1	3	3	1
801	14.5	2	1	1	2
802	14	1	1	2	2
803	14	2	2	1	1
804	14.5	1	1	1	2
805	14	2	1	1	2
806	14.5	1	1	1	2
807	14	2	1	1	1
808	14	1	1	1	2
809	14	2	1	1	2
810	14.5	1	1	1	2
811	14	2	2	3	1
812	14	1	1	1	2
813	14	2	1	1	2
814	14.5	1	1	1	2
815	14.5	2	1	1	2
816	14.5	1	1	2	1

KEY TO MASTER CHART

AGE: 14 years & 14.5 years

SEX: 1.Male ; 2.Female

BMI: 1: Normal ; 2: Over Weight ; 3.Obese

BP Classification: 1.Normal ; 2.Pre Hypertension ; 3.Hypertension

Family History: 1.Yes ; 2.No